COMPARISON OF TWO STANDING CROP ESTIMATORS IN SAGEBRUSH-STEPPE COMMUNITIES

Keith T. Weber and Glenn P. Russell
GIS Training and Research Center
Idaho State University
Pocatello, ID 83209-8130
(http://giscenter.isu.edu, e-mail: giscenter@isu.edu)

ABSTRACT

The use of direct sampling (using Daubenmire frame or hoop sampling) to estimate standing crop is widely used and effective, but time consuming. Visual obstruction is a non-destructive and less intensive alternative. Benkobi et al. found visual obstruction a reliable technique in Nebraska grasslands. We applied the same techniques in sagebrush-steppe communities and found visual obstruction routinely underestimated forage availability and was only weakly correlated with hoop sampling measurements (R^2 = 0.14).

Keywords: Grazing, Daubenmire frame, Direct harvest, Visual Obstruction, Robel.

INTRODUCTION

Accurately assessing standing crop on rangeland is important for livestock and wildlife management (Webb 1942, Benkobi et al. 2000, Thoma et al. 2002). Reliably calculating forage biomass and available AU's allows land managers to correctly prescribe stocking rates and promote healthy and sustainable rangelands. Using the direct-harvest (or hoop sampling) method (Daubenmire 1959, Milner and Hughes 1968, Pieper 1978, Pieper1988) is both destructive and time-intensive. However this technique has been demonstrated to be an accurate estimator of standing crop (Cochran 1977, Pieper 1988, Benkobi et al, 2000, Holechek et al 2001). For this reason, we assumed standing crop estimates derived from direct harvest accurately reflected existing range productivity. We then applied a non-destructive visual obstruction method (Benkobi et al. 2000) to estimate standing crop. Statistical comparisons were made to test correlation of visual obstruction results with accepted standing crop estimates. While Benkobi et al. (2000) demonstrated that visual obstruction correlated well with direct harvest and the weight-estimation (or double-sampling) methods (Pechanec and Pickford 1937) in Nebraska grasslands ($R^2 = 0.88$), this method has not been validated in sagebrush-steppe communities. The sagebrush-steppe community typically has a high bare ground component along with substantial shrub cover making visual obstruction more difficult to apply successfully.

The objective of this study was to determine the utility of the visual obstruction estimator as an alternative to direct harvest in sagebrush-steppe communities of the Upper Snake River Plain, Idaho. If proven reliable, the visual obstruction method would offer a more productive means to estimate standing crop.

METHODS

This study was conducted on land managed by the USDI BLM, Upper Snake River District in southeast Idaho. Sample points were located between $43^0$36’00” and $42^0$48’00” N latitude and –$113^0$35’00” and -$112^0$37’59” W longitude. This area is considered sagebrush-steppe semiarid-desert and is bordered by large, relatively recent lava formations (2000 years BP) to the south and west and irrigated agricultural lands to the east. This area has a history of livestock grazing and wildfire occurrence (Figure. 1).

One-hundred and twenty-eight sample points were randomly generated across the study area. Each point was located $\geq$70 m from a road to avoid edge effects. Sample points were stratified by grazing treatment (grazed versus ungrazed), fire history, and control. Fire history was determined using an historic wildfire (1939-2001) geographic information systems data set with samples categorized into no-fire, one-fire, or multiple-fire treatment classes (Table 1).

Two methods were used to estimate standing crop at each sample point. Firtst, direct harvest in which a 0.44 m^2 hoop was blindly tossed into each of four quadrants (NW, NE, SE, SW) centered over the sample point. All current year' above ground growth of grass and forbs (Shoop and McIlvain 1963) within the hoop was clipped and weighed (+/- 1 g). Standing crop (kg ha^{-1}) was calculated with "AUM Analyzer" software (Sheley 1999) by entering the four hoop sample weights and applying a dry-weight correction factor based on current phenology. Second, visual obstruction was measured using a modified Robel pole marked with alternating 2.54 cm bands of silver and black. Affixed to the bottom of the pole was a 25 cm spike that allowed it to stand free once the spike was pushed into the ground. The pole was located 10 paces (approximately 10m) from the sample point. One reading was made from each of four cardinal directions (N, S, E, and W). The observer stood 4m from the pole with his eye approximately 1m above the ground. The top band totally obstructed by forage was recorded. If sagebrush or other non-forage shrub was obstructing view of the pole, the observer simply stepped aside. These techniques are consistent with those reported by Benkobi et al. 2000.

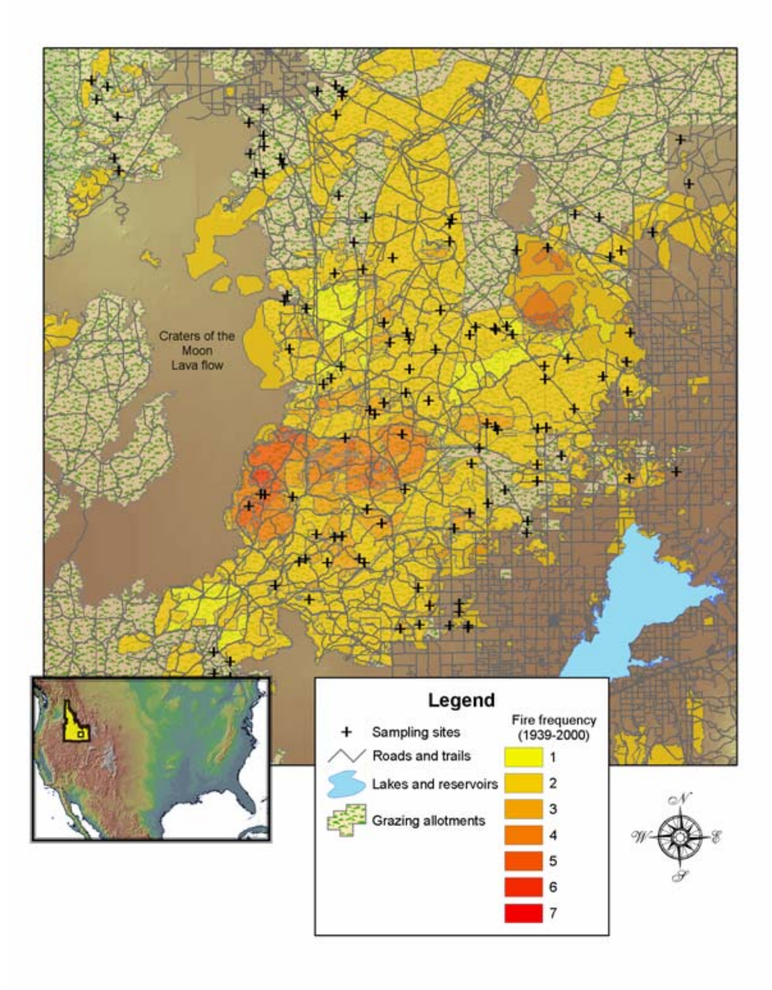

Figure 1. Study area with field sampling sites indicated.

Table 1. Stratification of treatments at sampling sites.

Sample Points	Fire Frequency				
Grazing	0	1	> 1	Total	Percent
Grazed	17	14	20	51	40
Ungrazed	33	28	17	78	60
TOTALS	50	42	37	129	100
Percent	39	33	29		100

Linear regression was used to determine the predictability of standing crop (as measured by direct harvest) using the mean of four visual obstruction readings per site.

RESULTS AND DISCUSSION

The mean, minimum, and maximum weight of clipped vegetation was 14, 0, and 95 g respectively. Mean standing crop was 87.8 kg ha^{-1}. The mean, minimum, and maximum visual obstruction reading was 3.81, 0.0, and 31.75 cm, respectively. There was no statistically significant relationship between measured standing crop and visual obstruction readings ($R^2 = 0.14$).

Many of the sample points had readings of 0 because the nearest plant did not obstruct our view of the pole. The visual obstruction method is best applied in grassland areas with 1) relatively high standing crop (≥300 kg ha^{-1}) and 2) grass species like those found in the Nebraska sandhills (e.g., Little bluestem (*Schizachyrium scoparium spp.*, prairie sand reed (*Calamovilfa longifolia spp.*), and needle-and-thread (*Stipa comata spp.*)) and northeast Kansas (Robel et al 1970). Further, we believe areas with a high bare-ground component are poor candidates for the visual obstruction method.

Other estimation techniques exist (Shoop and McIlvain 1963, Pearson and Miller 1972, Holmes 1974, Pieper 1988, Holechek et al. 2001) that may improve the efficiency of standing crop estimation. However, until other techniques are validated in sagebrush-steppe ecosystems, accurate standing crop estimates can only be achieved using standard hoop sampling techniques.

ACKNOWLEDGEMENTS

This study was made possible by a grant from the National Aeronautics and Space Administration Goddard Space Flight Center. ISU would also like to acknowledge the Idaho Delegation for their assistance in obtaining this grant.

LITERATURE CITED

Benkobi, L., D. W. Uresk, G. Schenbeck, and R. M. King. 2000. Protocol for monitoring standing crop in grasslands using visual obstruction. J. Range Manage. 53:627-633.

Cochran, W.G. 1977. Sampling techniques, 3rd ed. John Wiley Sons, Inc. New York, N.Y. 428 pp.

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Sci. 33(1)43-64.

Holechek J., R. D. Pieper, and C. H. Herbel. 2001. Range management: principles and practices, 4th ed. Prentice-Hall, Upper Saddle River, N.J. 587pp.

Holmes, C. W. 1974. The Massey grass meter. Dairy farming annual. pp.26-30.

Miller, R.F., T.J. Svejcar, and N.E. West. 1994. Implications of Livestock Grazing in the Intermountain Sagebrush Region: Plant Composition, Ecological Implications of Livestock Herbivory in the West. Society for Range Management. 297pp.

Milner, C. and R.E. Hughes. 1968. Methods for the measurement of primary production of grasslands. Blackwell Scientific Publications, Oxford, Great Britain.

Pearson, R.L. and L.D. Miller. 1972. Remote spectral measurements as a method for determining plant cover. US/IBP Grassland Biome Tech. Rep. no. 167, Colorado State Univ., Fort Collins, Colo.

Pechanec, J.F. and G.D. Pickford. 1937. A weight estimate method for determination of range or pasture production. J. Amer. Soc. Agron. 29:894-904.

Pieper, R.D. 1978. Measurement techniques for herbaceous and shrubby vegetation. New Mexico State Univ., Las Cruces, N.M.

Pieper, R.. D. 1988. Rangeland vegetation productivity and biomass, pp. 449-467. *In* P. T. Tueller (ed),Vegetation Science Applications for Rangeland Analysis and Management. Kluwer Academic Publishers, Norwell, Mass. 581pp.

Robel, R.J., J.N. Briggs, A.D. Dayton, and L.C. Hulbert. 1970. Relationships between visual obstruction measurements and weight of grassland vegetation. J. Range Manage. 23:295-297.

Sheley, R. 1999. AUM Analyzer Software, Montana State University, Bozeman, Mont.

Shoop, M.C. and E.H. McIlvain. 1963. The micro-unit forage inventory method. J. Range Manage. 16:172-179.

Thoma, D.P., D.W. Bailey, D.S. Long, G.A. Nielsen, M.P. Henry, M.C. Breneman, and C. Montagne. 2002. Short -term monitoring of rangeland forage conditions with AVHRR imagery. J. Range Manage. 55:383-389.

Webb, W.L. 1942. A method for wildlife management mapping in forested areas. J. Wild. Manage. 6:38-43.